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ABSTRACT

Linguistics is on the verge of becoming an experimental discipline; an undergraduate major tailored to reflect this can attract a wider range of students, relate linguistics subject matter to the real world in a more exciting way, challenge students to address more deeply the problems of philosophy and philosophy of science than in some other disciplines, and provide conceptual knowledge and practical skills for better employment potential. A range of experimental techniques have been used successfully in linguistics, and could be used by undergraduates with only a modest investment in equipment. These include experiments in phonetics, phonology, morphology, syntax and semantics, and interdisciplinary sub-areas of linguistics. Suggested print resources for each of these areas are appended. (MSE)

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LINGUISTICS IN THE UNDERGRADUATE CURRICULUM

APPENDIX 4-G

Linguistics as an Experimental Discipline

by

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The views expressed are those of the authors and do not necessarily reflect the position of the LSA or the National Endowment for the Humanities.

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PREFACE

The Linguistics in the Undergraduate Curriculum (LUC) project is an effort by the Linguistic Society of America (LSA) to study the state of undergraduate instruction in linguistics in the United States and Canada and to suggest directions for its future development. It was supported by a grant from the National Endowment for the Humanities during the period 1 January 1985-31 December 1987. The project was carried out under the direction of D. Terence Langendoen, Principal Investigator, and Secretary-Treasurer of the LSA. Mary Niebuhr, Executive Assistant at the LSA office in Washington, DC, was responsible for the day-to-day administration of the project with the assistance of Nicole VandenHeuvel and Dana McDaniel.

Project oversight was provided by a Steering Committee that was appointed by the LSA Executive Committee in 1985. Its members were: Judith Aissen (University of California, Santa Cruz), Paul Angelis (Southern Illinois University), Victoria Fromkin (University of California, Los Angeles), Frank Heny, Robert Jeffers (Rutgers University), D. Terence Langendoen (Graduate Center of the City University of New York), Manjari Ohala (San Jose State University), Ellen Prince (University of Pennsylvania), and Arnold Zwicky (The Ohio State University and Stanford University). The Steering Committee, in turn, received help from a Consultant Panel, whose members were: Ed Battistella (University of Alabama, Birmingham), Byron Bender (University of Hawaii, Manoa), Garland Bills (University of New Mexico), Daniel Brink (Arizona State University), Ronald Butters (Duke University), Charles Cairns (Queens College of CUNY), Jean Casagrande (University of Florida), Nancy Dorian (Bryn Mawr College), Sheila Embleton (York University), Francine Frank (State University of New York, Albany), Robert Freidin (Princeton University), Jean Berko-Gleason (Boston University), Wayne Harbert (Cornell University), Alice Harris (Vanderbilt University), Jeffrey Heath, Michael Henderson (University of Kansas), Larry Hutchinson (University of Minnesota, Minneapolis), Ray Jackendoff (Brandeis University), Robert Johnson (Gallaudet College), Braj Kachru (University of Illinois, Urbana), Charles Kreidler (Georgetown University), William Ladusaw (University of California, Santa Cruz), Ilse Lehiste (The Ohio State University), David Lightfoot (University of Maryland), Donna Jo Napoli (Swarthmore College), Ronald Macaulay (Pitzer College), Geoffrey Pullum (University of California, Santa Cruz), Victor Raskin (Purdue University), Sanford Schane (University of California, San Diego), Carlota Smith (University of Texas, Austin), Roger Shuy (Georgetown University), and Jessica Wirth (University of Wisconsin, Milwaukee).

Introduction.

The defining property of a discipline is the body of questions it asks about some aspect of the universe. Linguistics, although relatively young as a distinct discipline (a century or so), has embraced such age-old questions as: how is language represented in the mind?, how is language learned?, how is meaning conveyed by language?, what is the origin of language and speech? The personality of a discipline, however, is determined in part by how it goes about getting answers to its questions. Disciplines are thus commonly characterized as "soft" or "hard" depending on the methods they use to obtain the evidence needed to support or reject the candidate answers (hypotheses) put forth. Literary criticism is a good example of an unabashedly soft discipline; evidence cited for a particular view is seldom so definitive or convincing that reasonable individuals are prevented from offering competing views. Chemistry, on the other hand, merits the reputation of being a hard science because the range of acceptable evidence in support of a particular claim is drawn rather narrowly. Although the history of science tells us that no answers are forever secure, those obtained in the hard disciplines by means of experimental methods tend to have a much longer life-span.

Linguistics is on the verge of becoming an experimental discipline and an undergraduate linguistic major that is tailored to reflect this has the opportunity of:

--attracting a wider range of students to the major
--relating the subject matter of linguistics to the "real" world in a way that makes it more exciting to students
--challenges students to address more deeply problems of philosophy (epistemology) and philosophy of science than they would in disciplines not experiencing a transition in methodology.
--provides students with conceptual knowledge and practical skills which will open up to them a wider range of jobs and/or graduate school options after graduation.

The Essence of Experimentation.

Since there is much controversy over the nature of 'experiments' and even whether linguistics can ever be experimental, I had best define a few terms.

What is essential for experimentation is, first, an attitude and, second, a plan of action based on that attitude. The attitude consists simply of awareness that the world is not necessarily as it may seem, i.e., that our sense-impressions and therefore the opinions and beliefs based on them may be faulty. Given this attitude, one then needs to plan--to contrive--a study of the world in a way which compensates for anticipated sources of error. An experiment is a contrived observation. The contrivance may amount to being in the right place at the right time to make a crucial observation. An example is Eddington's test of Einstein's claim about the bending of the path of light near large masses; he traveled to the Gulf of Guinea when a solar eclipse would occur to see if a given star that should have been hidden behind the sun could actually be seen as its light curved around the sun. More often the experimenter himself contrives the circumstances giving rise to the events

that will be observed. An example is Pasteur's famous test of his anthrax vaccine by administering it to one group of sheep exposed to the disease and withholding it from another similar group. Making observations on many similar events compensates for unpredictable individual differences which might hide the object of the search; making similar observations on an experimental (treated) group and on a control (untreated) group are representative of the lore that experimenters in many different fields have accumulated over the centuries. Experimentation, then, amounts to taking as much care as possible to refine one's beliefs. Thus, to counter some common misconceptions: experimentation does not consist exclusively of data-gathering, whether with instruments or not and it is not an activity that ignores theory (or more properly, 'hypothesis') construction. Experimentation, properly viewed, is driven by theory and its results feed back into theory-making in a continuous loop.

Of course, trying to understand the behavior of living systems is more difficult than that of material systems since the former is subject to many more influences than the latter and it is accordingly more difficult to isolate one or a few of these factors while controlling the rest. It is even more difficult to study voluntary behavior such as speech and language which is shaped by a host of physical, psychological, and social influences. Nevertheless, as Claude Bernard, the "father of experimental medicine", remarked:

> Experimentation is undeniably harder in medicine than in any other science; but for that very reason, it was never so necessary, and indeed so indispensable. The more complex the science, the more essential it is, in fact, to establish a good experimental standard, so as to secure comparable facts, free from sources of error. [Bernard 1865 (1957: 2-3)]

Many linguists have come to the same conclusion and have begun the difficult task of trying to 'establish a good experimental standard' in linguistics. These efforts have born fruit; there is now a growing arsenal of experimental techniques of proven value for many kinds of linguistic hypotheses and there is a growing reliance on experimental results to resolve issues in the field. Several leading linguistics departments in North America have experimental linguistics as their major focus or as an important element in their program, e.g., University of Alberta (Edmonton), University of Connecticut, Brown University, Yale University, Ohio State University; excellent opportunities for experimental linguistics are available at the University of Wisconsin, University of Minnesota, University of Pennsylvania, University of Texas at Austin, UCLA, Univ. of California--Berkeley, University of California--San Diego, Cornell, Indiana University, New York University, among others.

What sorts of experiments are done?

Many linguistics experiments do not require expensive equipment (see Appendix A) although computers, various transducers, and other equipment may enlarge the range of experimental techniques permitted as well as make it easier to gather the evidential data faster and in greater volume.

The following examples of experiments done to test hypotheses in various sub-fields in linguistics are only meant to be suggestive of the range of techniques which have been successfully employed and which could be done by undergraduates in a program that had made only a modest investment in equipment. It is not suggested that these specific studies be repeated--although it often has considerable pedagogical value, not to mention scientific value, to replicate experiments previously reported.

A. Phonetics.

The experimental approach to linguistic questions has its longest history and best-established tradition in the domain of phonetics, with substantial but isolated pieces of research on the physical structure of speech sounds being done in the 18th and early 19th century and a self-sustaining tradition developing in the late 19th century (Rousselot 1892, 1897-1901). One of the most important contributions of modern experimental phonetics, armed as it is with instruments for detailed acoustic analysis and synthesis of speech, is the elucidation of the physical cues used by listeners to identify the units of speech (words, syllables, phonemes). This research has yielded sufficient information on the acoustic building blocks of speech that it is now possible to offer commercial systems which synthesize speech from unrestricted text input (of a given language). Details of the listener's task in decoding speech have emerged which would never have been suspected from formally-based speculation or from analysis by the unaided ear. For example, it is now clear that even for so-called "minimal" phonemic differences in language--such that between "pin" and "bin"--there is not just one acoustic cue but multiple cues carrying the distinction. Current interest in this area focusses on how listeners integrate these multiple cues and whether the integration process is driven by purely auditory constraints (the properties of the ear and the neurological apparatus serving it) or whether the listener's prior experience--particularly with the structure of his own native language--plays a part.

Fujimura, Macchi, & Streeter (1978) investigated one aspect of this in an experiment in which artificial intervocalic consonant clusters were created by splicing together taped syllables like 'eb' and 'de' yielding 'ebde'. When the interval between these two syllables is short, listeners tend to hear only one consonant, the second of the two, that is, the joined sequence sounds like 'ede'. However, there was a significant difference in the reactions of Japanese and English listeners to such sequences: the Japanese reported 'ede' in higher proportion than the English listeners presumably because their language permits no medial consonant clusters of this sort whereas English does (e.g., in "rubdown"). In addition to showing that the prior language experience of listeners determines how they integrate multiple cues in speech, this study also sheds light on the mechanisms which gave rise to the sound change whereby word-medial consonant clusters such as that in Latin nocte(m), "night", became Italian notte (Ohala, in press). Specifically, it suggests that the change could occur when a listener, as in the Fujimura et al. study, failed to detect or to rely on the cues for the first of the two consonants and, when repeating the word himself, reproduced it with the two sequential stops replaced by a single long stop.

B. Phonology

If phonetics studies how speech sounds are produced and perceived, phonology studies the behavior or patterning of speech sounds. It seeks answers to its questions in phonetic, psychological, and sociological factors.

Sound Change Studied in the Laboratory.

The study just cited which helps us to understand how a word-medial -ct- cluster could become -tt- (that is, due to listeners' misapprehensions) also illustrates how it is possible now for linguists to study one important form of speech sound behavior, sound change, in the laboratory. This constitutes as significant a breakthrough for linguistics as happened to astronomy when that field learned how to study the behavior of distant objects in the universe via controlled laboratory investigations. Neither has direct access to the object of their study but both can observe and manipulate in their labs the same phenomena (in miniature) which gave rise to the things they are trying to understand. Laboratory studies of sound change have been able to duplicate and obtain some understanding not only of attested sound changes but also of their relative incidence (vis-a-vis other potential sound changes) and their directionality (Ohala 1974, 1983a). These results, moreover, have application in the area of automatic speech recognition (ASR) insofar as it highlights the source of confusions in speech and how listeners try to compensate for them (Ohala 1985, 1986a).

Sound Symbolism.

In general, linguists recognize an arbitrary, purely conventional, connection between meanings and the sound sequences that carry the meanings. Thus the same object may be 'cup' in English, 'tasse' in French, and 'pyala' in Hindi. Nevertheless, there seems to be a small fraction of every language's vocabulary where the constituent sounds convey certain basic meanings in a more direct way and, moreover, showing the same sound-meaning correlation in several unrelated languages. For example, the vowels in 'teeny', 'wee', expressive words meaning "small", crop up in words with the same meaning in other language, e.g., French 'petit', Spanish 'chico', Japanese 'chiisai'. In one of the first psycholinguistic studies focussing on phonological questions, the American linguist Edward Sapir (1929) presented several native speakers of English and a few native speakers of Chinese with pairs of made-up words such as 'meel' and 'mal'--identical except for their vowels--and asked them to assign them as names to smaller and larger versions of objects, e.g., a table. In about 80% of the responses, both from English and Chinese speakers, vowels like 'ee' were chosen for the smaller item, lending support to the notion that there is a universally recognized connection between certain speech sounds and certain fundamental semantic categories. There has been considerable interest in this area recently and many experimental studies have replicated Sapir's findings and have explored other aspects of the phenomenon (Ohala 1984). Besides its inherent theoretical interest, this is an area with potential applications in such diverse areas as advertising (construction of product names) and stylistics, especially the analysis of poetry. A bibliography of experimental studies in sound symbolism is given in Appendix B.

Psycholinguistic Studies in Phonology.

After the vocal tract and the history of languages, perhaps the next great frontier to be explored in linguistics is the language user's mind, that is, what is in mind of the speaker which enables him to exhibit mastery of a language. Although barely out of its infancy--perhaps, 'adolescence' would be apt--studies of psychological mechanisms serving the phonological side of language are growing both in numbers and in the sophistication of the techniques. A relatively accessible method is concept formation in which subjects learn to classify presented words (or sentences) into various categories via simple feedback (signalling "right" or "wrong" to each response) (Jaeger 1980, 1986; Jaeger & Ohala 1984; Ohala 1983b). This has been used to test the claim that in English the affricates 'ch' and 'j' (e.g., at the beginning of 'choose' and 'juice') are psychologically single sounds even though physically they consist of stop-plus-fricative sequences (phonetic [tʃ] and [dʒ]). Using the concept formation technique, subjects were taught to classify words into those starting with clusters (e.g., 'stash', 'flow') and those starting with single consonants (e.g., 'thin', 'ship', 'fee')--even though some of these were spelled with two consonants. When words beginning with affricates were introduced (and where no feedback was given to subjects' responses), subjects overwhelmingly put them in the category of words starting with single sounds, thus supporting the tested hypothesis. Questions of this sort--and many more complex--arise every time a phonemic analysis is proposed for a language; it is now possible to resolve these issues through experimental means.

Appendix C provides a bibliography of experimental studies primarily in this area.

C. Morphology

Many of the issues in morphology are closely tied up with those in phonology, especially in the case of languages such as English which have a rich inflectional and derivational system, e.g., how do speakers of English compute the phonetic differences in the English plural, e.g., in 'cat[s]', 'dog[z]', 'finch[əz], as a function of the phonetic ending of the singular form? It is not feasible to go into detail here on the competing hypotheses but one issue concerns whether it is possible to posit just one psychological process for pluralization: a single marker, say [z], which then gets modified by rule as just indicated. Berko (1958) elicited the plurals of made-up words from English speakers (from pre-school age up to adults). (Made-up words were used instead of existing words to circumvent any claim that plural forms were known via rote memorization of all previously-heard plurals.) For her younger subjects she showed pictures of imaginary animals and prompted them as follows: "Here is one wug; now there are two of them. There are two ____" (where the child was encouraged to complete the last sentence). She found that her young subjects performed significantly less accurately with forms such as 'tors' than 'wugs', both of which should have taken the [z] form, thus suggesting that at least in its initial development the process of pluralization may not be unitary. Recent experimental work in morphology still uses such elicitation techniques with success as well as more elaborate methods (Bybee & Pardo 1981; Bybee & Slobin 1982).

D. Syntax; Semantics

The issues that occupy syntax and semantics are quite complex and most have not been subjected to experimental study--even though some of the earliest experimental psycholinguistic studies addressed issues that were topical in syntactic theory of the day (Osgood & Sebeok 1965; Flores d'Arcais & Levelt 1970). Nevertheless, considerable ingenuity--but not necessarily complex procedures or instrumentation--has been shown by workers in this area.

Blumenthal and Boakes (1967), for example, required subjects to memorize sentences of the type 'John is eager to please' and 'John is easy to please', i.e., with similar surface structure but with hypothesized different deep structures ('John' is the logical subject in the first sentence but is the logical object in the second), and then explored the effectiveness of the first noun ('John'in the above example) as a prompt for the recall. They found that "words functioning as logical subjects were significantly more effective prompts than words functioning as logical objects." Since the surface structure was identical in all pairs, the results lent support to the hypothesized difference in deep structure. Further support for such deep structures came from studies of ambiguous sentences, some of which derive their ambiguity from having more than one possible deep structure, e.g. 'they deplored the shooting of the hunters.' MacKay (1966), in a sentence-completion task, found subjects took longer to supply endings to ambiguous partial sentences presented to them than to non-ambiguous ones. This suggests that in hearing or reading one constructs all possible deep structures before arriving at a single interpretation of a sentence.

Other representative examples of experiments in this area include Sachs (1967), Jarvella (1971), Baker, Prideaux, & Derwing (1973), Berlin & Kay (1969), Carden & Dieterich (1981); reviews are given by Slobin (1979), Glucksberg & Danks (1975), and Prideaux (1985).

E. "Hyphenated" Linguistics.

Experimentation in some of the newer sub-areas of linguistics is characterized by impressive creativity. In a classic experiment, Labov (1966) demonstrated the existence in New York City of dialectal differences determined by social class, specifically the retention or dropping of 'r' after vowels. Entering three department stores catering to different social classes, he and his assistants asked the clerks for the location of some department that had previously been determined to be on the fourth floor. The responses of the clerks ('fawrθ flawr' or 'fawθ flaw') showed progressively higher percent of r-retention as one went from the working class store to the one catering to the highest class customers. Further experimental studies in sociolinguistics may be found in Labov (1972a,b). For other areas of hyphenated linguistics, see Read (1971) and Locke (1983) for language acquisition, Caplan (1987) for neurolinguistics, Ehri (1984, 1987) for reading and spelling acquisition.

F. Summary of Experimental Areas.

In the preceding survey I have emphasized the kind of experiments where the experimenter contrives the situation under which observations are made; there is also the potential for the other type of experiment: nature's experiment, as it were, where the observer just has to arrange to be in the right place at the right time to make the observation. Large collections of naturally-produced speech errors, for example, have provided crucial evidence relevant to issues in many domains in linguistics (Fromkin 1973, 1980; Stemberger 1983; Shattuck-Hufnagel 1986). Baars & Motley (1976) have developed ways of eliciting speech errors in the laboratory. Using them they have demonstrated, for example, that some sort of lexical editor must play a role in speech production since subjects--given equal opportunities to spoonerize words where the rearrangement would produce existing words and where they would produce nonsense (e.g., "barn doors" when spoonerized would yield the existing words "darn bores", whereas "dart board" if treated similarly would only yield the nonsense sequence "bart doard")--spoonerized the first type significantly more often (Baars, Motley, & MacKay 1975).

Appendix D provides a list of selected works that could serve as texts in courses of various kinds dealing with experimental linguistics.

Pedagogical Advantages of an Experimental Approach to Linguistic Issues.

Linguistics is noted for instilling in students a capacity for what is known as 'critical thinking'. This is doubly the case with experimental linguistics. As is common to all linguistic work students must examine data in detail to determine what generalizations they can draw from them but with an experimental approach they must in addition conceive of ways of testing those generalizations--devise ways to obtain new data which would successfully differentiate between competing generalizations.

The experimental approach is not universally endorsed among linguists (nor was it endorsed by all practitioners of medicine and physiology in the mid-19th century; see Helmholtz 1877 [1971]--such may be a natural feature of disciplines undergoing changes in methodology). Some have argued that linguistics cannot be an experimental discipline, cannot achieve the level of prediction of the "hard" sciences, and that it deals with propositions that are inherently untestable (Itkonen 1978; Lass 1980; for an opposing view see Ohala 1986b, 1987a,b; Ohala & Jaeger 1986). Students who approach linguistics experimentally will have to face these issues and also question very deeply their own and others' assumptions about such fundamental philosophical notions as what it means to 'know' something, the relative merits of knowledge derived from sense data vs. reason--or both-, what 'certainty' means, and even how well language or mathematics do at representing the world. They will have to delve into the history of linguistics and--in an enlightened curriculum--the history of other sciences, e.g, physics, chemistry, geology, biology. In this way a properly designed undergraduate major in linguistics with an experimental emphasis could provide a truly outstanding "liberal" education, covering hard and soft sciences as well as history and philosophy while at the same time involving students directly in reshaping linguistic science. (See Appendix E for a selected bibliography on history and philosophy of science.)

It is inevitable when learning about the experimental techniques suitable for the testing of linguistic hypotheses that students will learn about concepts and methods in other disciplines, e.g., psychology, computer science, statistics, mathematics, and--insofar as they give instructive examples of the success of experimentation--the history and practice of 'hard' sciences such as physics, chemistry, and biology. This feature of experimental linguistics in an undergraduate curriculum may also allow it to attract a wide range of students--in terms of background and temperament.

Students' familiarity with experimental methods will make them eligible for a wider range of jobs and a wider range of disciplines for further, advanced study. Undergraduates are currently obtaining entry-level jobs in the speech and language technology industry. Linguistics undergraduate students with such training are also highly successful in gaining admission to programs of advanced study in library science, speech pathology, and pre-medical training, and, of course, linguistics itself (in addition to areas where experimental training is of less value, e.g., law, business administration, modern languages).

Necessary Resources.

Although it is possible to do some form of experimental linguistics on a very modest budget and with little outlay for equipment, it is far easier and imposes fewer limitations on the type of experiments that can be undertaken if there are adequate resources.

The following would be desirable:

> Tape recorders plus associated equipment: earphones, amplifiers, loudspeakers, tape splicing equipment.
>
> Sound-treated room (for recording).
>
> Micro-computer system for digitizing, viewing, editing, analysis, and synthesis of speech and other audio signals; programs for obtaining reaction times, tabulating subjects' responses, performing statistical analyses.

In addition, a supply of motivated subjects is desirable, where motivation is typically provided by giving students academic credit for their participation or by paying them. In many cases, however, linguistics students themselves are not suitable as subjects in linguistics experiments because they might easily figure out the hypothesis being tested and come to the task with certain biases.

Some of these facilities may already be in place in other departments, e.g., psychology, speech and hearing science. In general, there would be considerable advantage to involving faculty from other departments in the implementation of a curriculum featuring experimental linguistics.

Library Resources.

In addition to the usual journals covering theoretical and descriptive linguistics, a program in experimental linguistics should ideally augment their holdings to include the journals listed in Appendix F.

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Journal Abbreviations Used Appendices:

BLS	Proc., Annual Meeting, Berkeley Linguistics Society
CLS	Proc, Regional Meeting, Chicago Linguistic Society
JASA	Journal of the Acoustical Society of America
JSHR	Journal of Speech and Hearing Research
JVLVB	Journal of Verbal Learning & Verbal Behavior
Lg	Language
Lg & Sp	Language & Speech

APPENDIX A; BIBLIOGRAPHY OF EXPERIMENTS WHICH CAN BE REPLICATED USING LITTLE MORE EQUIPMENT THAN A TAPE RECORDER*

(*The extra equipment includes: additional tape recorders, splicing equipment, a source of noise--which may be on a tape--, response buttons, earphones, etc.)

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APPENDIX D: BIBLIOGRAPHY OF WORKS THAT COULD BE USED AS TEXTS IN COURSES ON EXPERIMENTAL LINGUISTICS.

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APPENDIX E: SELECTED READINGS ON HISTORY & PHILOSOPHY OF SCIENCE

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APPENDIX F: SELECTED JOURNALS RELEVANT TO EXPERIMENTAL LINGUISTICS

Acustica
Am J. of Psychology
Applied Psycholinguistics
Cognition
IEEE Transactions, esp. those on Audio & Electroacoustics
IRAL (Int'l Rev. of Applied Ling.)
J. Acoustical Society of America
J. of Child Language
Journal de Psychologie Normale et Pathologique (Formerly, J. de Psychologie)
J. Experimental Psychology
J. of the International Phonetic Association
J. of Phonetics
J. of Psycholinguistic Research
J. of Speech & Hearing Disorders
J. of Speech & Hearing Research
J. of Verbal Learning & Verbal Behavior; now: Language & Memory.
Language Learning
Language & Speech
Perception & Psychophysics
Phonetica
Phonology Yearbook
Psychological Reviews
Speech Analysis
Studia Phonologica (Kyoto)
TESOL Quarterly
Zeitschrift fur Phonetik und Sprachwissenschaft...